

Prentice Hall

EARTH SCIENCE



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Chapter

20

Weather Patterns and Severe Storms

20.1 Air Masses

Air Masses and Weather

◆ Air Masses

- An **air mass** is an immense body of air that is characterized by similar temperatures and amounts of moisture at any given altitude.

◆ Movement of Air Masses

- As it moves, the characteristics of an air mass change and so does the weather in the area over which the air mass moves.

Tornado Damage



Frigid Canadian Air Mass Moves Southward

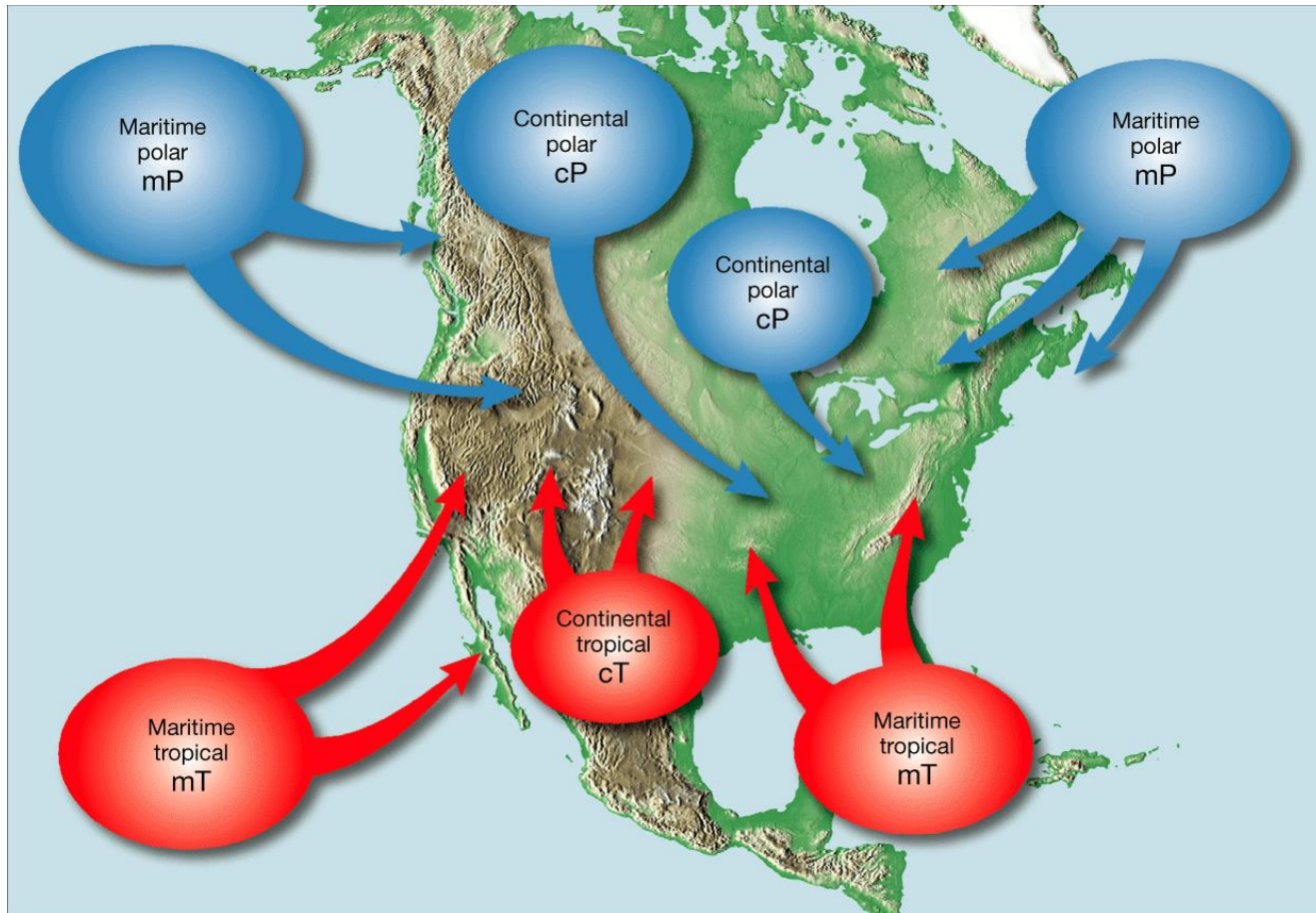


20.1 Air Masses

Classifying Air Masses

- ◆ In addition to their overall temperature, air masses are classified according to the surface over which they form.

Air Masses Are Classified by Region



20.1 Air Masses

Weather in North America

- ◆ Much of the weather in North America, especially weather east of the Rocky Mountains, is influenced by continental polar (cP) and maritime tropical (mT) air masses.

20.1 Air Masses

Weather in North America

◆ Continental Polar Air Masses

- Continental polar air masses are uniformly cold and dry in winter and cool and dry in summer.

◆ Maritime Tropical Air Masses

- Maritime tropical air masses are warm, loaded with moisture, and usually unstable.
- Maritime tropical air is the source of much, if not most, of the precipitation received in the eastern two-thirds of the United States.

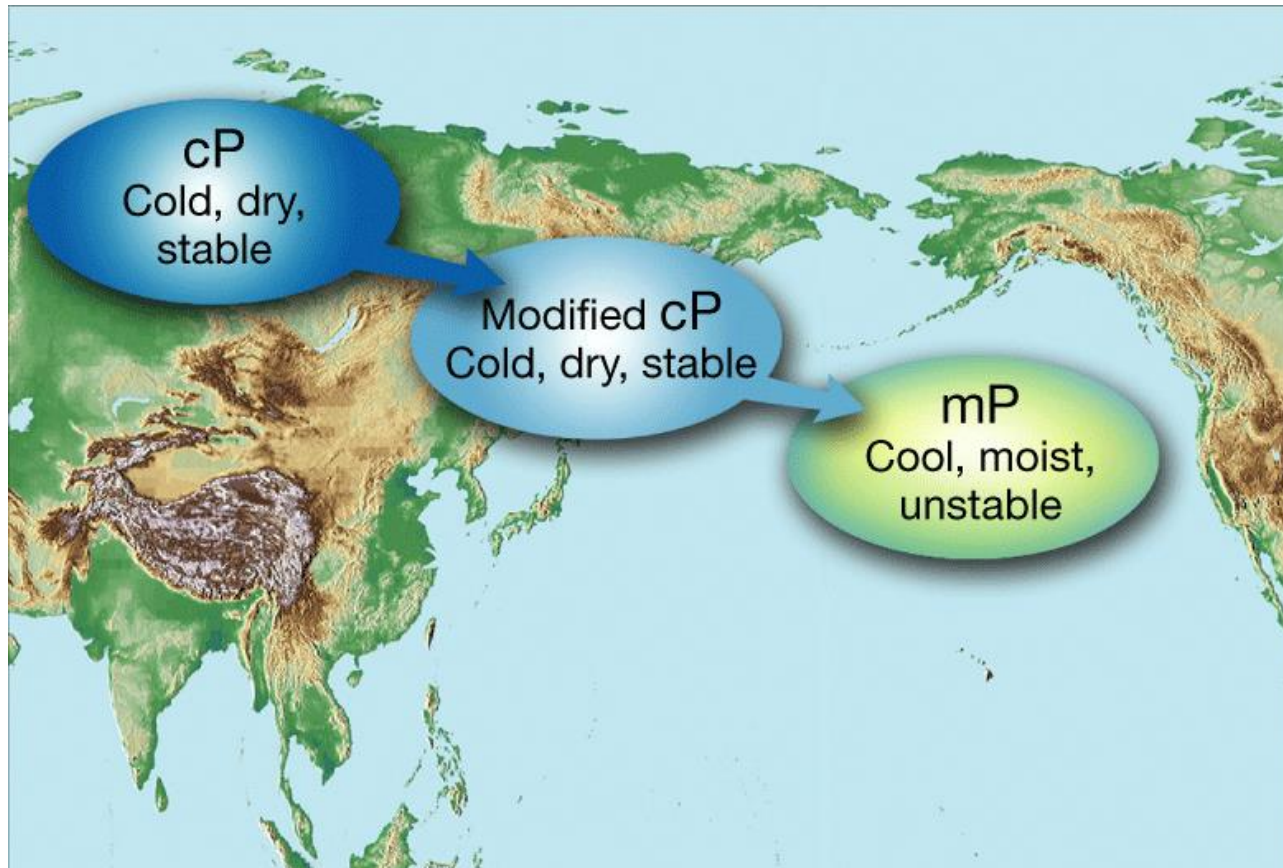
20.1 Air Masses

Weather in North America

◆ Maritime Polar Air Masses

- Maritime polar air masses begin as cP air masses in Siberia. The cold, dry continental polar air changes into relatively mild, humid, unstable maritime polar air during its long journey across the North Pacific.
- Maritime polar air masses also originate in the North Atlantic off the coast of eastern Canada.

Maritime Polar Air Masses



20.1 Air Masses

Weather in North America

◆ Continental Tropical Air Masses

- Only occasionally do cT air masses affect the weather outside their source regions. However, when a cT air mass moves from its source region in the summer, it can cause extremely hot, droughtlike conditions in the Great Plains.
- Movements of cT air masses in the fall result in mild weather in the Great Lakes region, often called Indian summer.

20.2 Fronts

Formation of Fronts

- ◆ When two air masses meet, they form a **front**, which is a boundary that separates two air masses.

20.2 Fronts

Types of Fronts

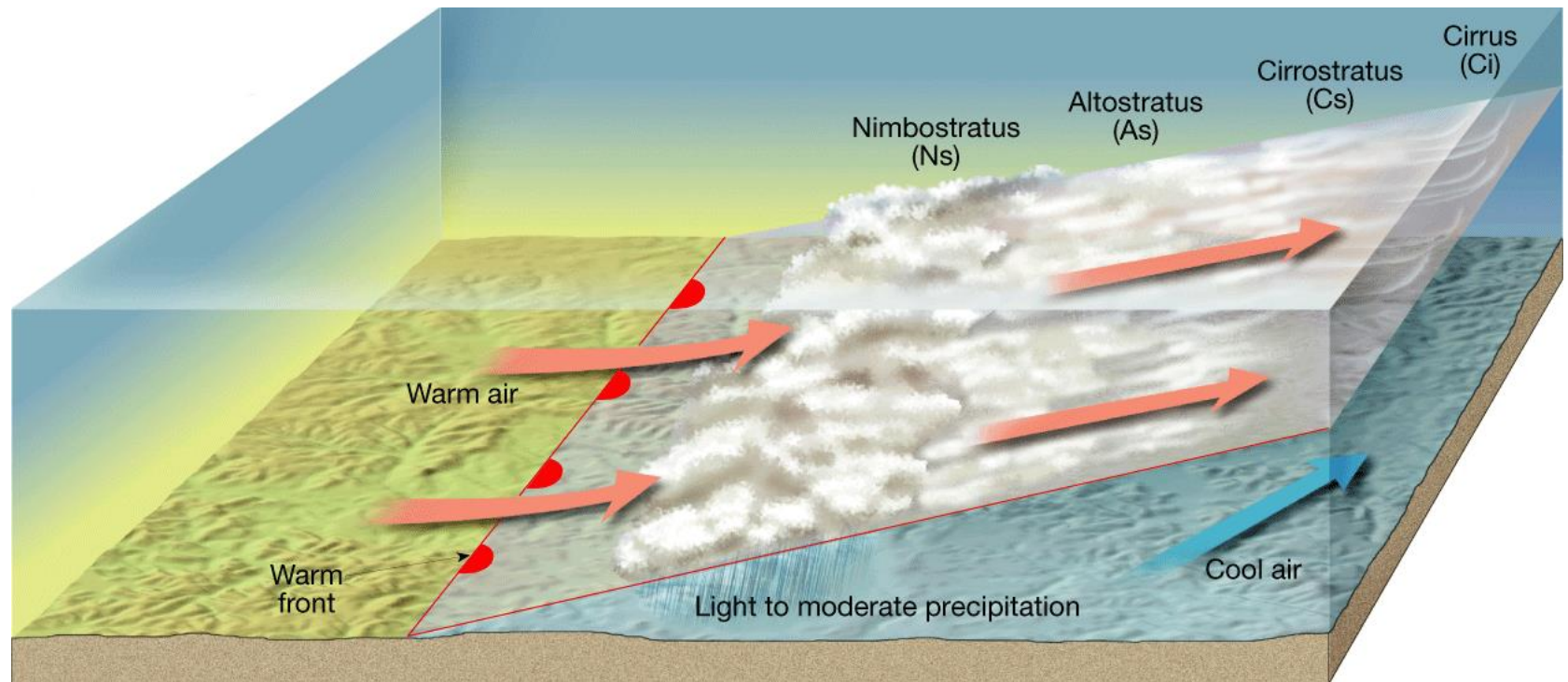
◆ Warm Fronts

- A **warm front** forms when warm air moves into an area formerly covered by cooler air.

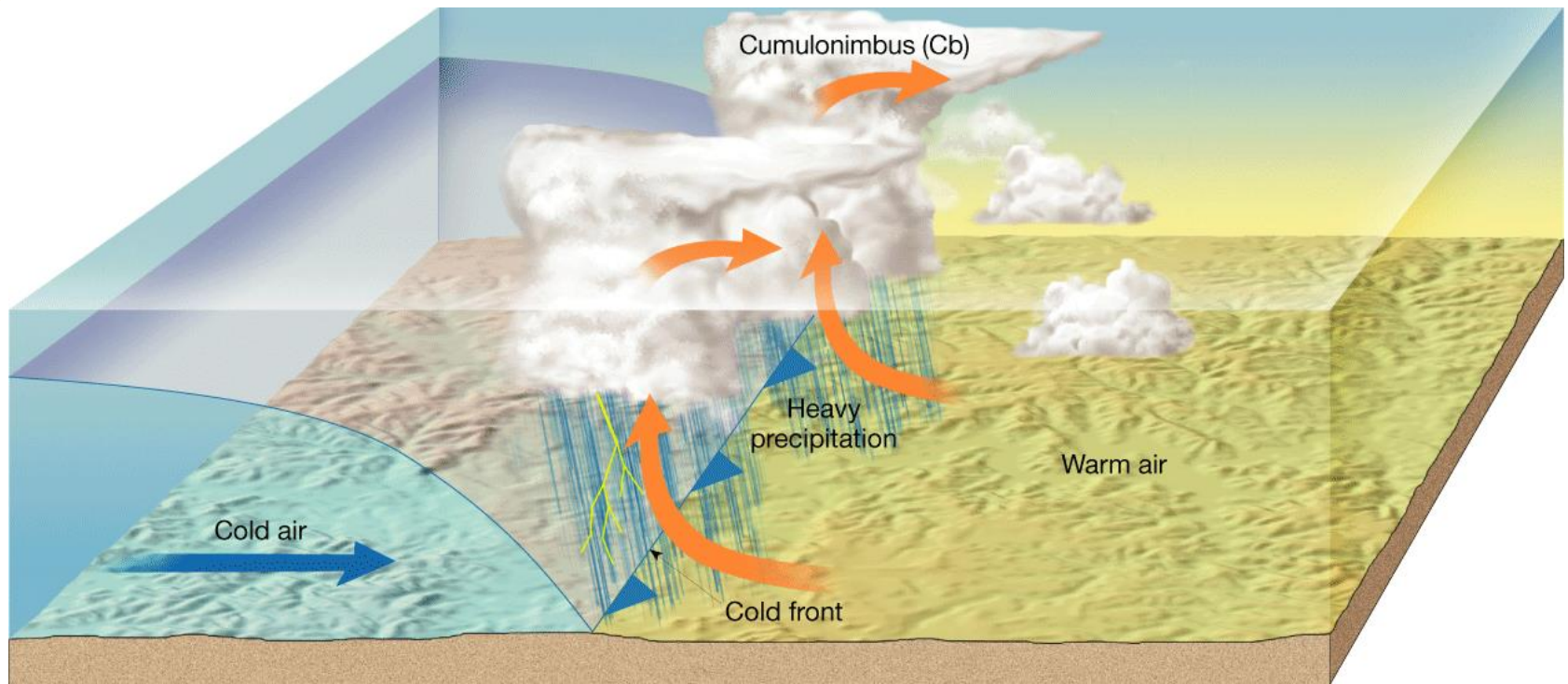
◆ Cold Fronts

- A **cold front** forms when cold, dense air moves into a region occupied by warmer air.

Formation of a Warm Front



Formation of a Cold Front



20.2 Fronts

Types of Fronts

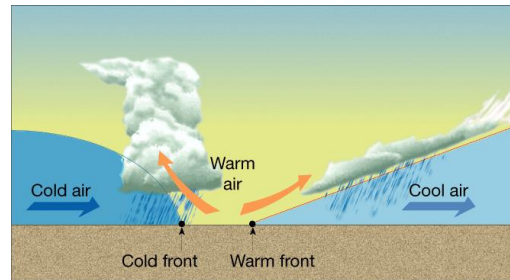
◆ Stationary Fronts

- Occasionally, the flow of air on either side of a front is neither toward the cold air mass nor toward the warm air mass, but almost parallel to the line of the front. In such cases, the surface position of the front does not move, and a **stationary front** forms.

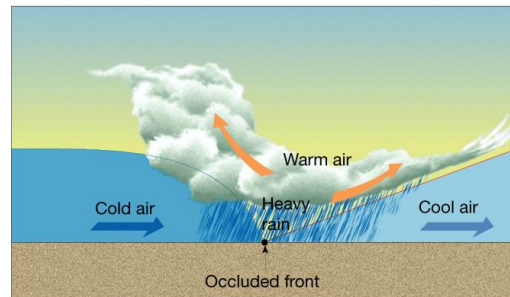
◆ Occluded Fronts

- When an active cold front overtakes a warm front, an **occluded front** forms.

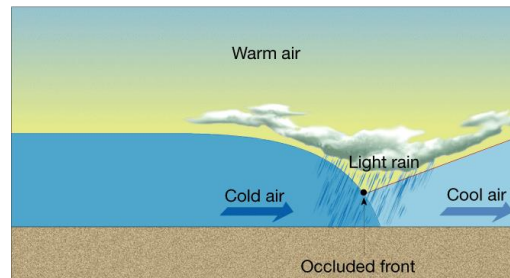
Formation of an Occluded Front



A cold front moves toward a warm front, forcing warm air aloft.



A cold front merges with the warm front to form an occluded front that drops heavy rains.



Because occluded fronts often move slowly, light precipitation can fall for several days.

20.2 Fronts

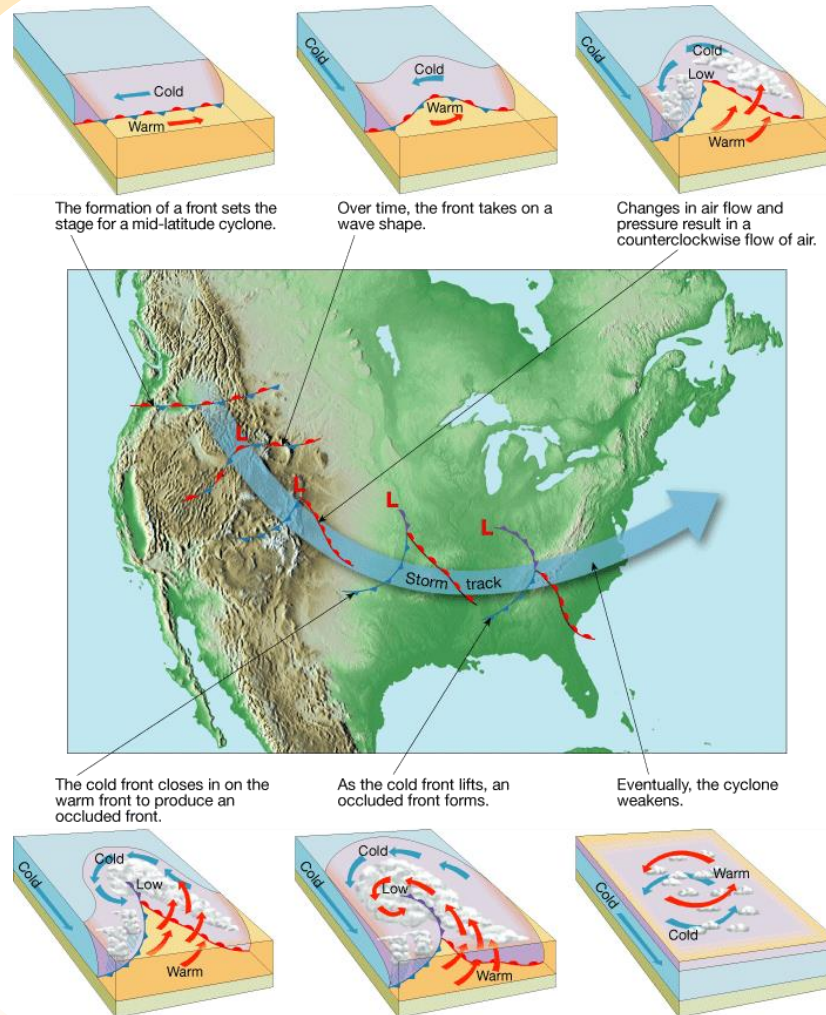
Middle-Latitude Cyclones

- ◆ Middle-latitude cyclones are large centers of low pressure that generally travel from west to east and cause stormy weather.

Satellite View of a Mature Cyclone



Middle-Latitude Cyclone Model

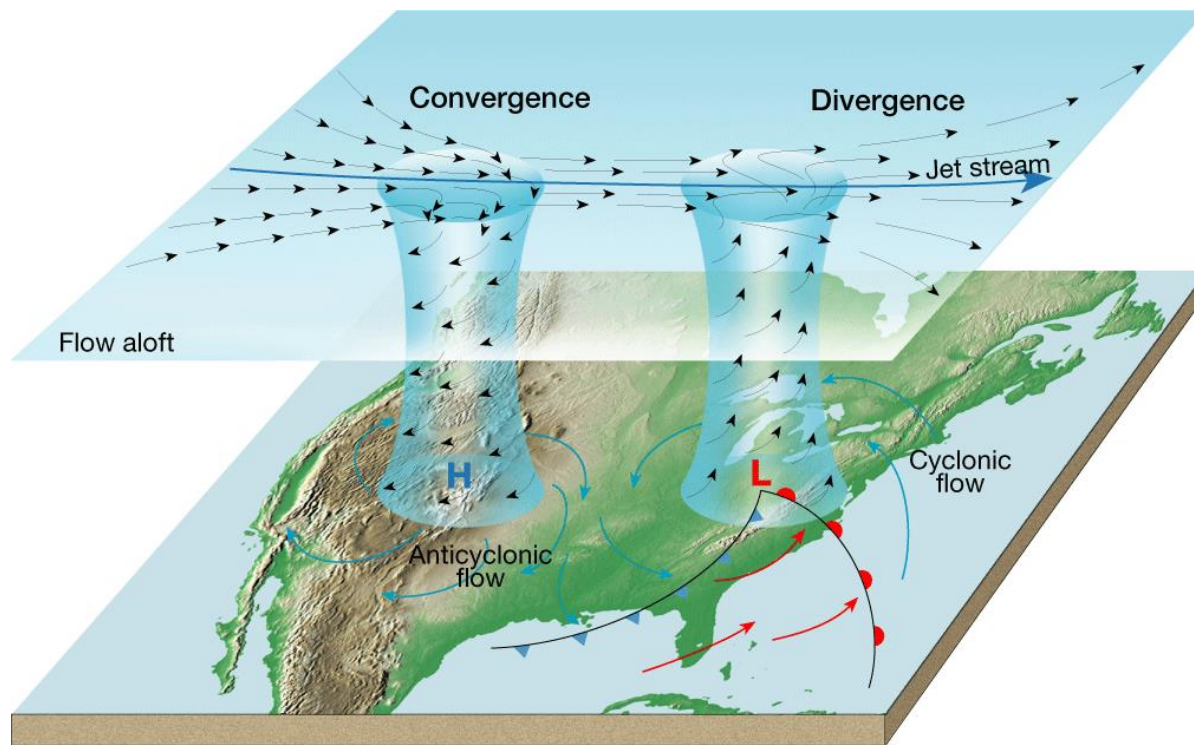


20.2 Fronts

The Role of Airflow Aloft

- ◆ More often than not, air high up in the atmosphere fuels a middle-latitude cyclone.

Movements of Air High in the Atmosphere



20.3 Severe Storms

Thunderstorms

- ◆ A **thunderstorm** is a storm that generates lightning and thunder. Thunderstorms frequently produce gusty winds, heavy rain, and hail.

20.3 Severe Storms

Thunderstorms

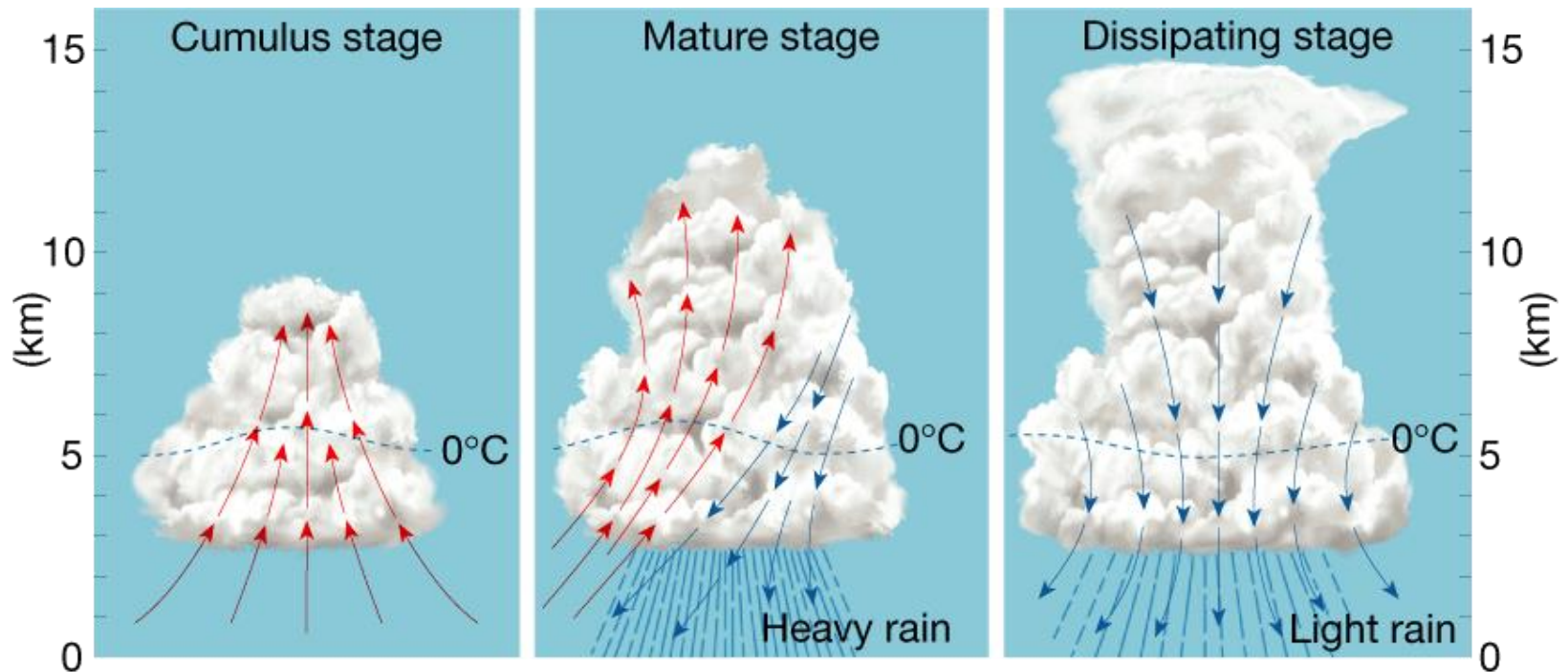
◆ Occurrence of Thunderstorms

- At any given time, there are an estimated 2000 thunderstorms in progress on Earth. The greatest number occur in the tropics where warmth, plentiful moisture, and instability are common atmospheric conditions.

◆ Development of Thunderstorms

- Thunderstorms form when warm, humid air rises in an unstable environment.

Stages in the Development of a Thunderstorm

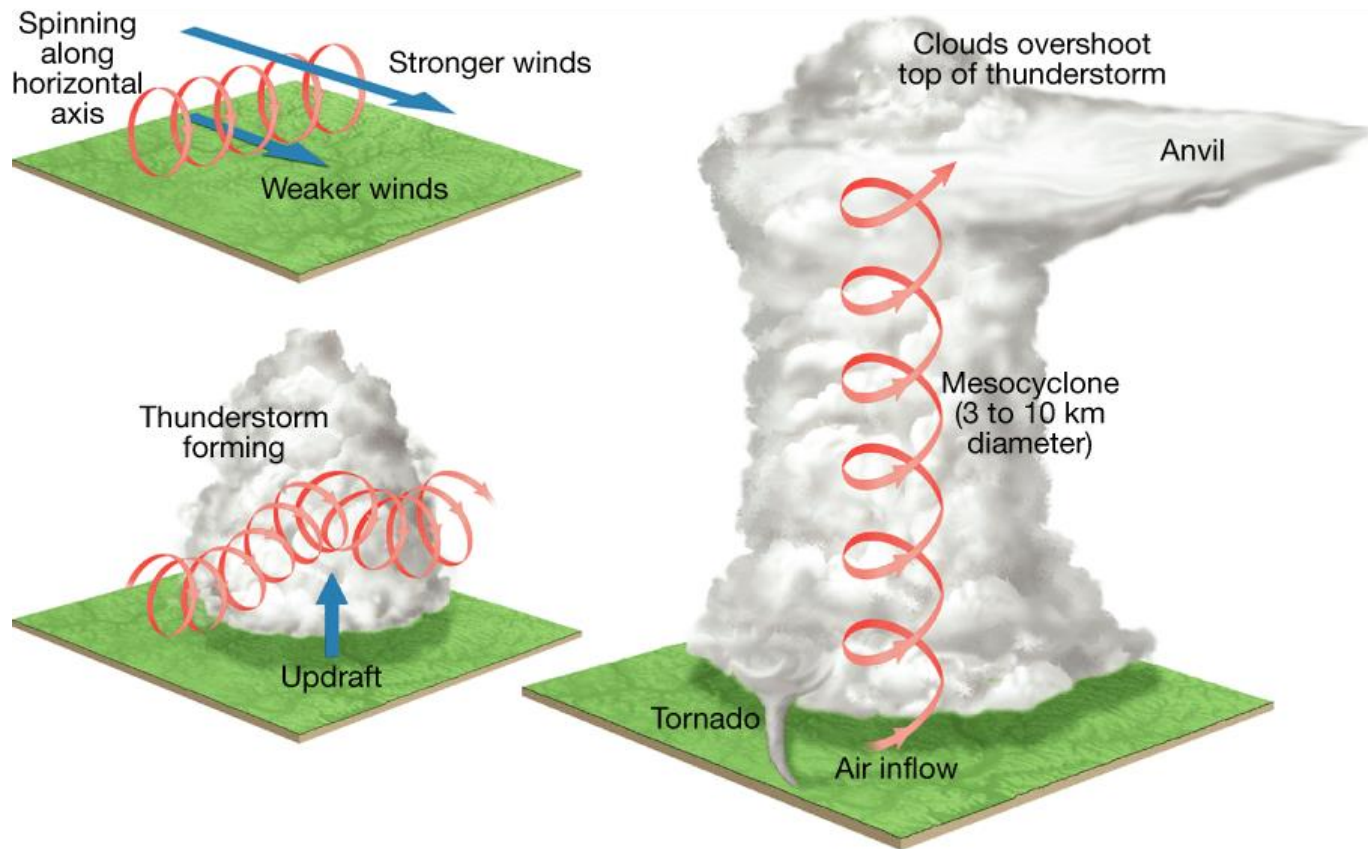


20.3 Severe Storms

Tornadoes

- ◆ **Tornadoes** are violent windstorms that take the form of a rotation column of air called a vortex. The vortex extends downward from a cumulonimbus cloud.
- ◆ Occurrence and Development of Tornadoes
 - Most tornadoes form in association with severe thunderstorms.
 - A mesocyclone is a vertical cylinder of rotating air that develops in the updraft of a thunderstorm.

Formation of a Mesocyclone



20.3 Severe Storms

Tornadoes

◆ Tornado Intensity

- Because tornado winds cannot be measured directly, a rating on the Fujita scale is determined by assessing the worst damage produced by the storm.

◆ Tornado Safety

- Tornado watches alert people to the possibility of tornadoes in a specified area for a particular time.
- A tornado warning is issued when a tornado has actually been sighted in an area or is indicated by weather radar.

Fujita Tornado Intensity Scale

Table 1 Fujita Tornado Intensity Scale

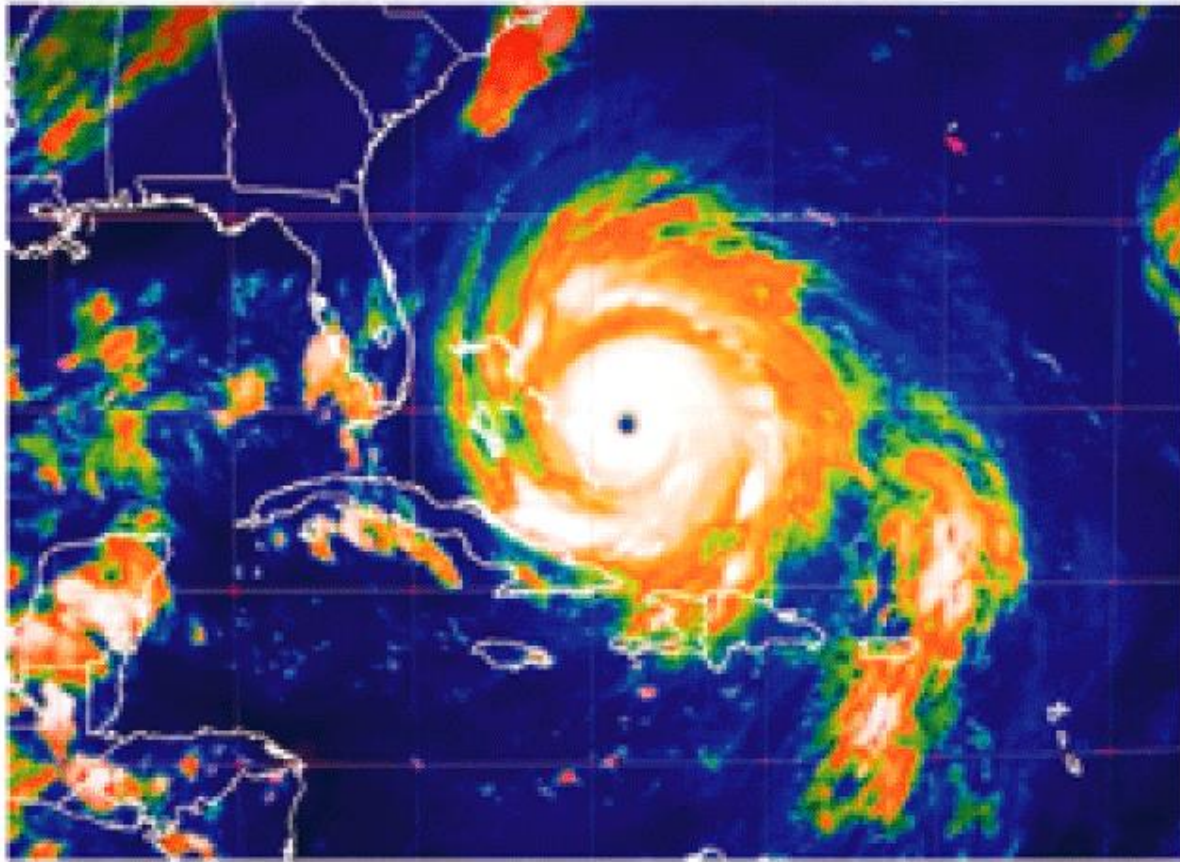
Intensity	Wind Speed Estimates (kph)	Typical Damage
F0	< 116	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	116–180	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving cars blown off roads.
F2	181–253	Considerable damage. Roofs torn off frame houses; mobile homes demolished; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	254–332	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	333–419	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown some distance; cars thrown; large missiles generated.
F5	> 419	Incredible damage. Strong frame houses lifted off foundations and carried away; automobile-sized missiles fly through the air in excess of 100 m; bark torn off trees.

20.3 Severe Storms

Hurricanes

- ◆ Whirling tropical cyclones that produce winds of at least 119 kilometers per hour are known in the United States as **hurricanes**.
- ◆ Occurrence of Hurricanes
 - Most hurricanes form between about 5 and 20 degrees north and south latitude. The North Pacific has the greatest number of storms, averaging 20 per year.

Satellite View of Hurricane Floyd



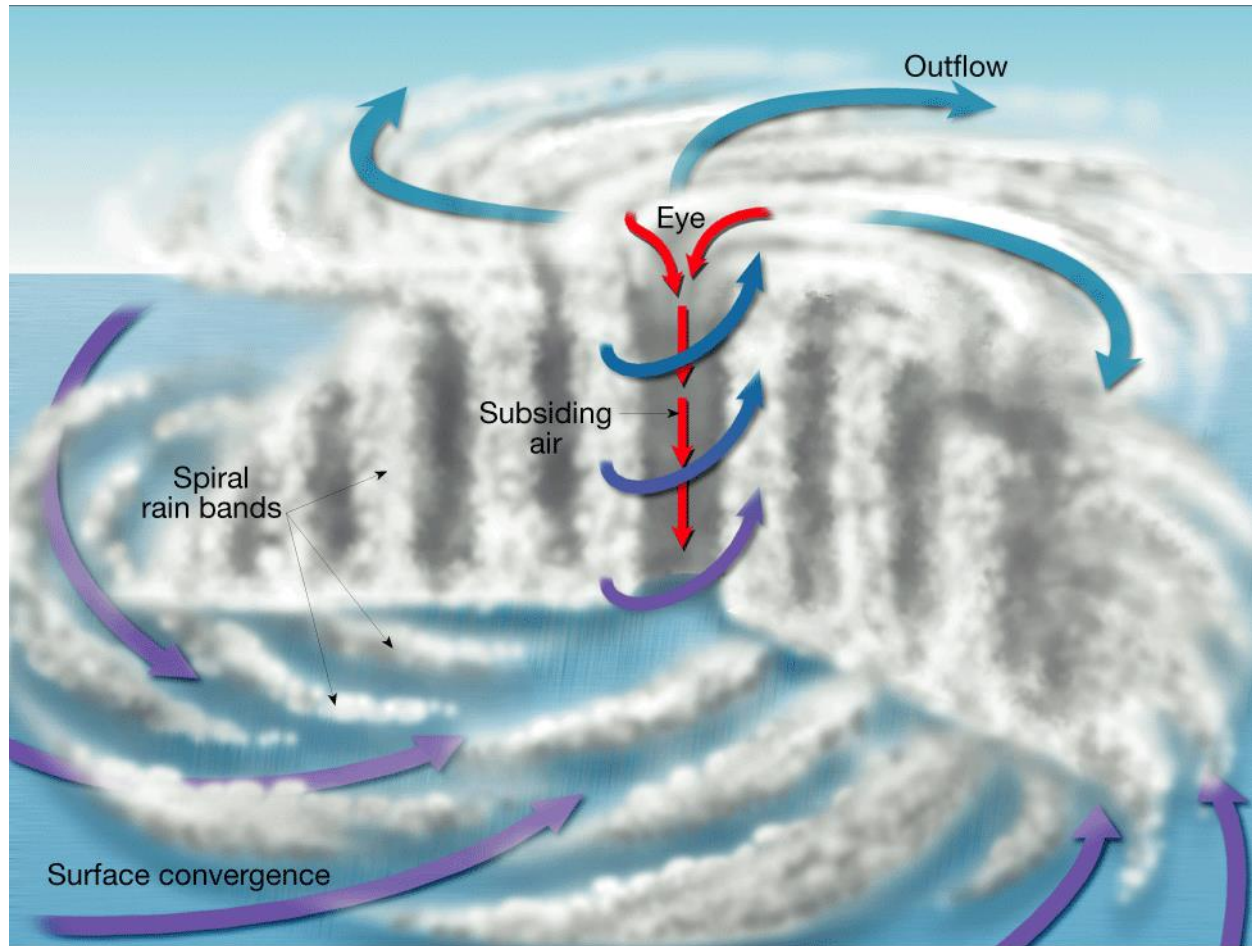
20.3 Severe Storms

Hurricanes

◆ Development of Hurricanes

- Hurricanes develop most often in the late summer when water temperatures are warm enough to provide the necessary heat and moisture to the air.
- The **eye** is a zone of scattered clouds and calm averaging about 20 kilometers in diameter at the center of a hurricane.
- The **eye wall** is a doughnut-shaped area of intense cumulonimbus development and very strong winds that surrounds the eye of a hurricane.

Cross Section of a Hurricane



20.3 Severe Storms

Hurricanes

◆ Hurricane Intensity

- The intensity of a hurricane is described using the Saffir-Simpson scale.
- A **storm surge** is the abnormal rise of the sea along a shore as a result of strong winds.

Saffir-Simpson Hurricane Scale

Table 2 Saffir-Simpson Hurricane Scale

Category	Sustained Wind Speeds (kph)	Typical Damage
1	119–153	Storm surge 1.2–1.5 meters; some damage to unanchored mobile homes, shrubbery, and trees; some coastal flooding; minor pier damage.
2	154–177	Storm surge 1.6–2.4 meters; some damage to buildings' roofs, doors, and windows; considerable damage to mobile homes and piers; moderate coastal flooding.
3	178–209	Storm surge 2.5–3.6 meters; some structural damage to small buildings; some large trees blown over; mobile homes destroyed; some coastal and inland flooding.
4	210–249	Storm surge 3.7–5.4 meters; severe damage to trees and signs; complete destruction of mobile homes; extensive damage to doors and windows; severe flooding inland.
5	> 249	Storm surge >5.4 meters; complete roof failure on many buildings; some complete building failure; all trees and signs blown away; major inland flooding.